TESTING OF GFRP COMPOSITES WRAPPED OVER EXTERIOR BEAM-COLUMN JUNCTION

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1 Introduction

Fiber Reinforced Polymer Composites (FRPCs) have become popular for civil engineering applications, especially in structural up gradation due to their sound engineering properties. It is successfully employed as external confinement in form of wrap for improving strength and ductility of existing Reinforced Concrete (RC) structures.

Beam-Column (B-C) junction plays a very important role in Moment Resisting (MR) framed structures, when it is subjected to seismic loading. Amongst all junctions, exterior junction considered as the most critical due to asymmetric loading under seismic action [1]. To study the behavior of Glass Fiber Reinforced Polymer Composites (GFRPC) wrapped over exterior B-C junction, it is essential to adopt proper testing setup. Thus, Present study is focused on different aspects of such testing setup.

2 Boundary Condition for Testing Setup

2.1 Selection of Boundary & Loading Condition

To obtain accurate experimental results during testing, it is essential to choose proper boundary conditions and loading actions. Based on this criterion, exterior junction of G+1 MR frame subjected to seismic load (Fig. 1. {A}), analytically compared with one independent exterior junction (same scale as MR frame) with three different conditions as follow.

1. Column with hinged boundary conditions and 30% axial force of its load carrying capacity (260 kN) (Fig. 1. {B}).
2. Column with hinged boundary conditions without any axial force (Fig. 1. {C}).
3. Column with fixed boundary conditions and 30% axial force of its load carrying capacity (260 kN) (Fig. 1. {D}).

This study is carried out with help of "ETABS 8 Nonlinear". From comparisons in Fig. 1., alternative {B} of testing setup proves compatible with actual condition {A}. Therefore, in order to achieve accurate experimental results it is necessary to provide hinges at both ends of column subjected to axial force.

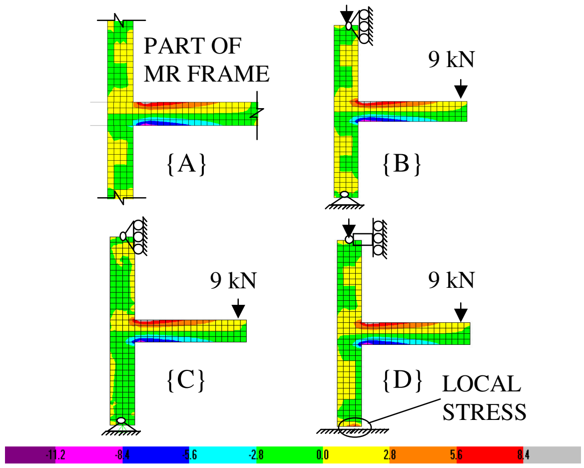

Fig. 1. Comparison, in terms of stresses (N/mm^2)

2.2 Fabrication of Hinges

As discussed, hinges should be provided at both ends of axially loaded column to permit rotation in junction during application of load at tip of the beam. Thus, design and fabrication of hinges need utmost attention to provide stability and proper function during testing. Two different alternatives of hinges are discussed here with help of Fig. 2 {E} & {F}.

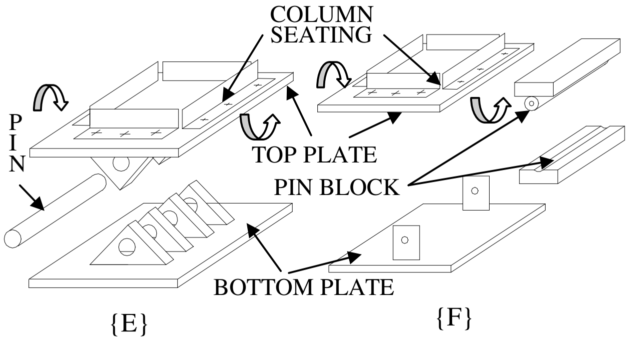

Fig. 2. Alternatives for hinges

As shown in Fig. 2., hinge action in alternate {E} is given by *pin* and in alternate {F} it is given with help of *pin block*. Due to axial force in hinge, *pin* is subjected to shear stresses (Permissible ≤ $0.4f_y$), and *pin block* is subjected to axial force (Permissible ≤ $0.6f_y$) [2]. Therefore, alternate {F} is selected for testing and fabricated as shown in Fig. 3. This alternate ensures maximum rotation of ± 30°.

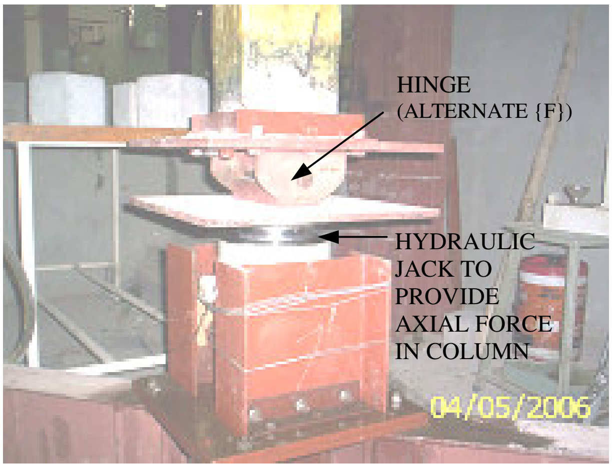

Fig. 3. Fabricated hinge

3 Cyclic Load

In current testing setup provisions are made to apply cyclic load with help of hydraulic jacks to simulate seismic action (As shown in Fig. 4.)

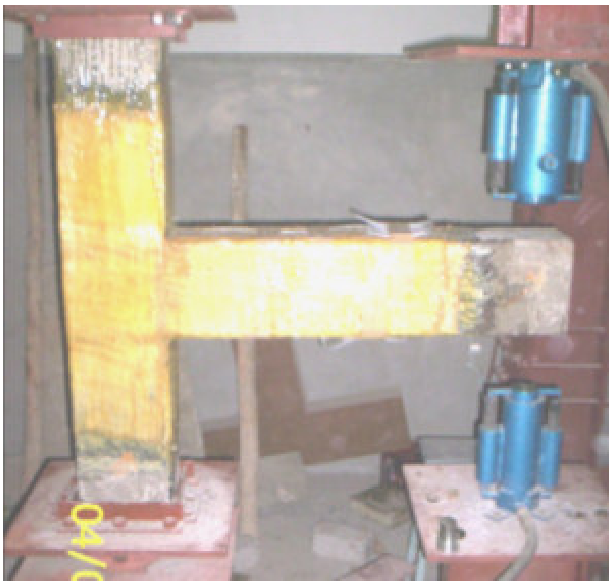

Fig. 4. Setup to apply cyclic action

According to Antonpoulous P. (et al.) [3] and Raghava S. (et al.) [4], ± 5mm variation in displacement for cyclic load is selected and applied at tip of the beam to simulate seismic action.

4 Application of GFRP Over Test Specimen

Since, effectiveness of wrapping system depends upon its bonding capacity with parent material and continuity of fiber effects the bonding capacity, care is taken to provide continuity of fibers while applying GFRP over test specimen. As shown in Fig. 5, different methods are used for wrapping B-C junction with unidirectional GFRP sheet.

From shown methods of wrapping, method {H} is selected because it ensures continuity of fibers and as a result, it improves bonding of fibers with parent material.

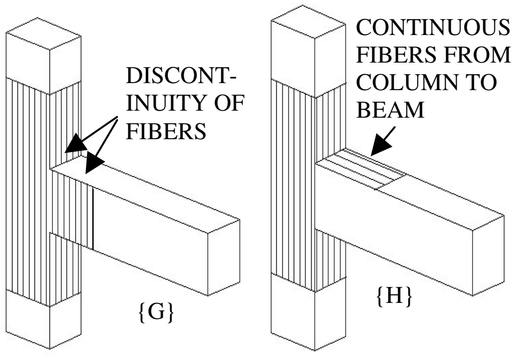

Fig. 5. Different methods of wrapping

5 Monitoring of Testing

Being integrated part of testing setup; monitoring equipment affects the testing results. On current setup, response of the test-specimen is measured in terms of strain induced near joint area and load corresponding to displacement at tip of the beam. Strain is measured with help of electronic strain gauges (at horizontal surface) and digital strain gauges (at vertical surface). Load is measured by load cell and displacement is measured by LVDT.

References

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